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World Animal Review

CONTENTS

COVER PHOTOGRAPH: A Javanese farmer washes his buffaloes in the Solo river, Indonesia. Water buffaloes are of considerable economic importance in southeast Asia.

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World Animal Review

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Control measures against contagious bovine pleuropneumonia in Ivory Coast

E.P. LINDLEY*

Most of the 383 000 cattle in Ivory Coast are humpless *Bos taurus* of the N'dama and Baouli breeds which are kept in small sedentary herds, but there are also some 50 000 zebu cattle, or *Bos indicus*, in semimigratory herds in the north. More than 135 000 slaughter cattle are imported annually from neighbouring savanna countries, mostly from Mali, Upper Volta and Niger. Although many of these animals are trekked through the country on approved stock routes, these importations are nevertheless responsible for the repeated reintroduction of contagious bovine pleuropneumonia (CBPP), a disease which has been recorded in Ivory Coast for many years. The last wave of infection reached a peak in 1965 with nearly 100 outbreaks but more recently the incidence has been reduced to 10 to 15 outbreaks annually. In accordance with definitions provided in the report of a subcommittee of the FAO/OIE/OAU Panel of Experts on Contagious Bovine Pleuropneumonia (FAO, 1971) Ivory Coast must be considered an "exposed zone" and the disease incidence classfied as "sporadic."

Until the middle of the eighteenth century CBPP was confused clinically with rinderpest, but its occurrence was relatively limited in extent until movement of cattle in the nineteenth and twentieth centuries spread the infection through Europe and to many parts of the world. Over the past century eradication has been achieved in Europe, North America, South

FIGURE 1. A chronically infected cow which is useless for production.

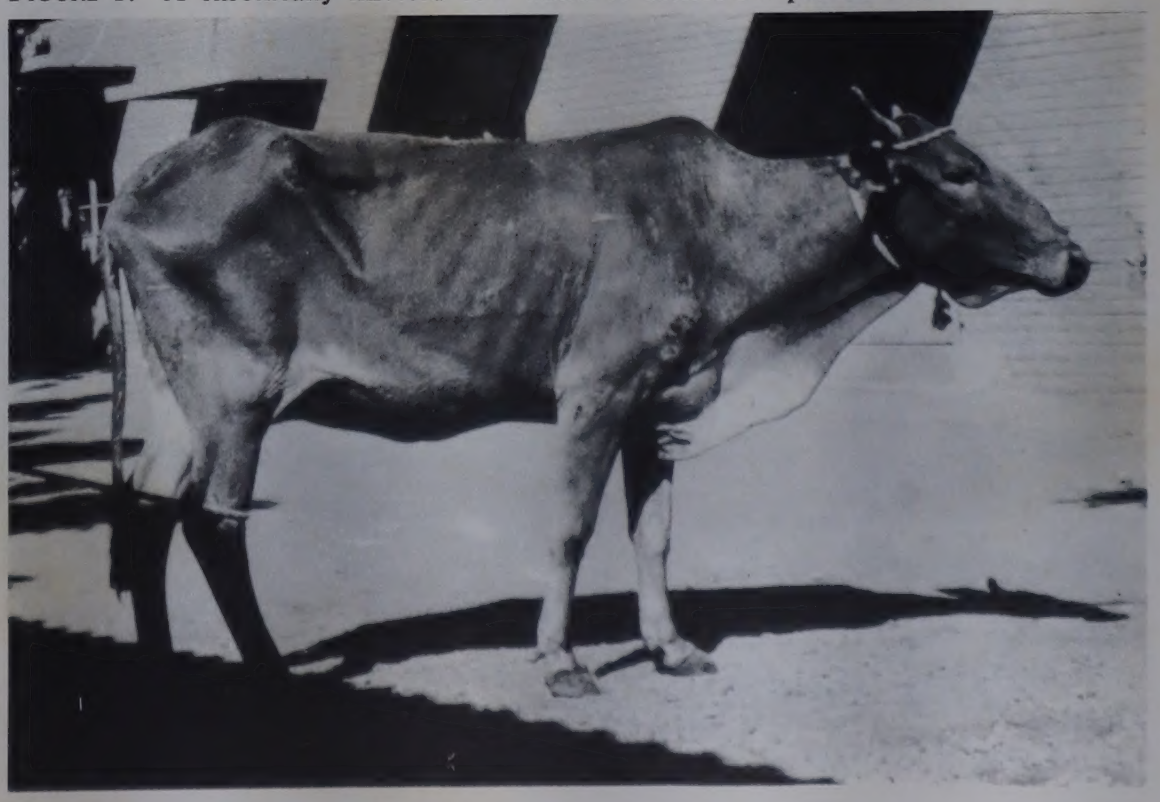

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FIGURE 2. Cattle are restrained traditionally with a form of lasso, which is laborious, slow and not without danger.

Africa and Australia, but CBPP remains a serious problem in some territories of Africa south of the Sahara and in limited areas of Asia (for example, Assam), and recently in parts of China and Mongolia (FAO/WHO/OIE, 1972).

The causative agent *Mycoplasma mycoides* is transmitted in droplets in the breath of infected cattle to in-contact cattle. Being very infectious it spreads rapidly, causing an acute or chronic, debilitating and sometimes fatal disease which seriously retards development of the cattle industry. Unfortunately, the measures which must be imposed to control the disease are often resented by stockowners since they involve restrictions on cattle movement, closure of markets and the slaughter of diseased animals. Fortunately, CBPP is not communicable to man and the meat from animals slaughtered because of the disease may be passed for human consumption, provided that the carcass passes standard meat hygiene requirements.

FIGURE 3. The cattle are sedentary, and in the rainy season the mud makes working conditions impossible.

General aspects of the disease

Some aspects of the disease may be confusing and it is essential to build up the confidence of those dealing with it. For example, all infected cattle do not become ill and an animal serologically positive to the complement fixation (CF) test may have no visible lung lesions. On the other hand, an apparently healthy animal may have a lung lesion and may spread infection when in contact with susceptible cattle in markets, along stock routes or while grazing. These chronic carriers can be detected by CF tests but the necessary facilities required for testing are not readily available. CBPP is taken into clean areas chiefly by such chronic carrier animals and can be introduced into a herd quite unwittingly, thus leading to a new outbreak. The seriousness of the introduced infection is variable, depending upon herd susceptibility. It has been noticed that in some outbreaks only one or a few animals may be clinically affected but in other outbreaks large numbers may show clinical evidence of the disease and mortality may be high. In one outbreak, 49 died in a herd of 117 animals.

When susceptible cattle are introduced into an infected herd, as happens with calves and replacement stock, the outbreak may be prolonged. Even when all clinical cases are removed and vaccination is carried out, the duration of infectivity of an affected herd should be considered as being two years rather than three to six months as is often quoted in sanitary regulations.

Although the technical procedures to control and to eradicate CBPP are well defined, the extent to which

control programmes are pursued in many countries often falls short of requirements. This is partly because the means in terms of staff, equipment and organization are often lacking, but there are other considerations. For example:

when the disease occurs at the sporadic level it may not cause sufficient immediate financial loss to stimulate enough animal owners to seek remedial action;

animal production may not be sufficiently important in the economy of the country to warrant giving high priority to the control of CBPP;

because of bad communications and the wide dispersion of cattle, an intensive campaign may not be economically justifiable;

in view of proposed regional projects, supported by foreign aid, local animal health services have not always demanded sufficient funds for their national programmes.

Epizootiology in Ivory Coast

As stated previously the disease is introduced in most instances into sedentary herds by imported cattle and may then spread to neighbouring herds, thus giving rise to secondary outbreaks. Because of the settled character of village husbandry it is possible, however, to bring the disease under control comparatively quickly. Slaughter of sick animals is now compulsory in Ivory Coast. This is a notable advance because until the law was changed in 1966 the customary treatment of clinical cases contributed to the persistence of the disease.

The immediate limitation of CBPP in Ivory Coast depends on the successful immunization of the national herd. The disease could be eradicated if continued reexposure to infection could be prevented, but it seems unlikely that the cattle-exporting countries of the Sahelian zone, in which there is much nomadism, will be able to eliminate CBPP in the near future. However, it is to be expected that the incidence will decrease. The eventual eradication in Ivory Coast depends on complete separation of slaughter and breeding stock.

Vaccines and vaccination

Several CBPP vaccines have been used in Ivory Coast but since 1967 two lyophilized products based on strains T_1 and KH_3J have been in general use. Both are produced at the laboratory of the Institut d'élevage et de médecine véterinaire des pays tropicaux at Dakar, Senegal.

The T_1 lyophilized vaccine has been tested in Senegal (Doutre and Chambron, 1970) and in Ivory Coast (Lindley, 1971). As a prophylactic agent it is a most stable and dependable product affording an immunity of approximately 12 months. Its efficacy is now generally accepted but in the humpless breeds of Ivory Coast it produces a small proportion of postvaccinal reactions of subcutaneous, oedematous swellings at the point of inoculation. Its use therefore requires a second visit 14 days after vaccination to examine the stock for progressive subcutaneous lesions and, if necessary, to provide drugs for their treatment. The number of animals showing undesirable reactions is much reduced after the second and subsequent vaccinations. Until 1970 it had been recommended that calves under six months should not be vaccinated, but in two outbreaks in early 1970 losses were confined to the younger animals which had been omitted from the previous vaccination campaign. All calves are now included and no difficulties have been experienced.

The KH_3J lyophilized vaccine has been used for countrywide vaccination, but the results are more difficult to assess. While this vaccine does not cause postvaccinal complications, it appears that the level of herd immunity after vaccination is lower and it seems doubtful if its continued use in its present form is justified. Trials with adjuvants to improve the efficacy of KH_3J vaccine, and with vaccines made from other strains at different levels of attenuation, have been carried out, but so far with little success. When facilities and staff are adequate to handle the T_1 vaccine this product should replace the KH_3J vaccine.

Ear punching as a mark of vaccination enables immediate confirmation of the status of an individual animal. It provides a means of checking that the vaccination of herds has been carried out and enables independent counts to be made to ascertain the extent of coverage that is being achieved. Ear punching has to be limited to the first three annual vaccinations, however, in order to avoid excessive mutilation of the ears.

Present methods of control

Legal powers for compulsory vaccination against CBPP have existed in Ivory Coast since 1967 and the veterinary authority carries out mass vaccination as far as means permit. The use of T_1 vaccine is being extended as staff gain confidence and experience in the use of this product.

Instructions for the control of outbreaks can be summarized as follows:

1. Submit specimens for laboratory examinations to confirm or refute the diagnosis.
2. Explain to the owner the object and advantages of veterinary intervention.
3. Vaccinate with T_1 vaccine *as soon as possible* all animals in the contaminated herd and all herds inside a circle of 10-kilometre radius around the outbreak.
4. On the same day separate clinically sick animals from the rest of the herd and identify the sick animals by hot-iron branding.
5. Slaughter sick animals either on the site or in the nearest abattoir (under veterinary supervision).
6. Inquire in the village how the infection gained access and write up all the information on the pro forma provided and submit it as a report with the official declaration.
7. Visit the herd after two weeks and remove any sick animals.

Check on postvaccinal lesions and treat as necessary.

8. Revaccinate the contaminated herd three months after the first vaccination and every six months thereafter for two years.

Although a problem exists in the delay in taking action due to late reports by owners and the lapse of time before local veterinary intervention, the foregoing procedures have worked well during the past three years.

Sometimes, even if CBPP is suspected, the diagnosis cannot be confirmed. In such cases an immediate vaccination of the suspected herd with T_1 vaccine is undertaken and blood samples are taken from 20 percent of the animals, including any showing suspicious clinical signs, for examination. In the event of a positive laboratory diagnosis, the sanitary measures given above are applied.

Legislation exists for diseased animals to be branded and slaughtered and for the imposition of a "standstill" order in the locality. Vaccination followed by revaccination after three months is compulsory and some compensation is payable for vaccinated animals slaughtered under the Act. It is desirable as a long-term policy to have legislation under which all animals in infected herds could be branded. Such powers will certainly be needed when an eradication policy is introduced. At present, however, branding is resented by the sedentary herd owners but anything which leads the owner to conceal the presence of the disease should be avoided; a dynamic vaccination policy and the early reporting of disease require cooperative owners.

Present regulations for imported slaughter stock in Ivory Coast include the compulsory use of defined stock routes for cattle on the hoof, the issue of movement permits and health certificates, including details of the most recent vaccinations against rinderpest and CBPP, as well as the quarantine and vaccination of unvaccinated animals.

Large groups of trade cattle coming through recognized frontier posts can be reasonably controlled until slaughter, whether they move on the hoof or are transported. There is also a traditional but limited migratory movement of zebu herds; but the movement of cattle brought into Ivory Coast for sale in markets just inside the frontier is very difficult to supervise. It is for this reason, and also because of the cost involved, that systematic blood testing of imported cattle for CBPP is unlikely to be successful because only those cattle presented for inspection can be tested. The cattle which filter across the frontier in small groups and constitute the greatest threat would escape testing.

Some animals moving on the hoof have not been slaughtered until four months after entering the country. If imported stock could be taken by lorry or rail direct to slaughter the danger of disease transmission would be reduced. Another approach would be to enact legislation making it an offence to introduce into breeding herds cattle imported for slaughter. On entry, permits could be given specifically for slaughter *or* breeding and the few animals allowed into the country for breeding purposes could be subject to quarantine and other health checks. After some years of applying such regulations there would be a good case for branding all imported slaughter stock.

FIGURE 4. Crushes greatly facilitate vaccination campaigns.

Diagnosis

Laboratory facilities are necessary for an intensive campaign against CBPP, not only to check vaccines and the efficiency of vaccination but also to introduce precision into the diagnosis. When the laboratory at Korhogo was established as the centre for CBPP control in Ivory Coast, field staff immediately submitted specimens for confirmation of diagnosis. Such a specialized unit gives considerable moral support in dealing with a difficult disease and acts as a centre for specialized training.

Several outbreaks in local herds have been discovered from slaughtered animals whose lungs, during meat inspection, have been found to be diseased. In two cases, the animals sold for slaughter were the only cattle that were clinically affected in the herd and laboratory tests were essential to confirm the diagnosis.

The importance of accurate data regarding the origin of each outbreak and the necessity to confirm the diagnosis are continually being stressed.

After years of vaccination, it is known that outbreaks occur involving only one or two young animals; in such atypical cases laboratory confirmation of the diagnosis is essential.

FIGURE 5. A laboratory assistant carries out the diagnostic test for CBPP.

Training

CBPP is a disease associated with the movement of cattle but it is also a disease of "development." The most important factor in its control is the degree of efficiency of the veterinary service. The practical measures taken against CBPP in Ivory Coast are carried out by animal health assistants under veterinary supervision; hence it is vital that auxiliary staff should understand clearly exactly what must be done, and how and when it should be done. To make these points clear, laboratory facilities have been provided to confirm diagnosis of the disease; an extension service has been organized; procedure sheets have been prepared, especially for assistants, covering all aspects of control; and a teaching group consisting of a trained team has been established to demonstrate control measures. The training of animal health assistants to form a task force in the fight against CBPP is a crucial part of any campaign.

Costing of CBPP

Attempts to estimate the cost of CBPP have been made but the importance of the disease as an obstacle to the development of the animal industry is difficult to calculate in monetary terms. Prophylactic vaccination on a countrywide basis is relatively expensive. It is economically sound for Ivory Coast to develop and improve notification procedures and to use thoroughly trained personnel to deal immediately and dynamically with each outbreak. Better handling facilities, such as cattle crushes, would be a great asset in increasing efficiency and reducing the cost of vaccination campaigns; simultaneous vaccination of stock against other diseases (for example, rinderpest) with compatible vaccines would reduce the per caput cost of vaccination.

It might be appropriate to consider giving cattle owners a bonus for early reporting of CBPP but such payment would have to be quite separate from the existing compensation scheme. When eradication becomes a possibility and there is systematic slaughtering of serologically positive cattle in addition to clinical cases, the amount of compensation per animal will have to be reassessed.

Conclusions

It is expected that the countries exporting cattle to Ivory Coast will gain a better control over CBPP. They are already cooperating in a more efficient control of the movement of trade cattle. Until imported stock can be guaranteed to be free from infection — or all slaughter cattle kept completely separate from breeding herds — the eradication of CBPP will not be practicable in Ivory Coast.

Annual prophylactic mass vaccination is expensive and coverage depends on available funds. Regular herd inspections and more publicity for the symptoms of CBPP would improve reporting of the disease and lead to the speedier implementation of sanitary measures to limit outbreaks.

The key to control is confident, experienced personnel, but they need to be backed by laboratory facilities and by a specialized CBPP unit. Short of eradication on a regional basis, the veterinary authority will need to continue the present control policy and outside aid should be directed to supporting this action.

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Performance recording for animal improvement

R.E. HODGSON*

Although the volume of world animal production is huge in the aggregate, it could be much greater if animal productivity were everywhere as good as it could be. An increase of perhaps one third could be obtained from present animal populations and with no greater demands on land resources if development and management of both animals and land in the developing countries were commensurate with that found in the developed countries.

Development of animal resources can be achieved by: improvement in genetic ability to produce; improvement in feed supplies and proper rationing; improvement in the care and management of the animals in herds or flocks; and the control and abatement of diseases and parasites.

Performance recording

Many governments, educators and producers in developing countries have undertaken improvement programmes in some or all of these phases with varying degrees of success. This article is concerned with the need for a programme that includes most of these phases and is fundamental to success in all of them — a record-of-performance programme used on individual farms and ranches to record regularly the production of each animal in the herd or flock on a continuing basis. Such a programme will provide the producer with information to make sound decisions to increase productivity immediately and, in the long run, to make greater profits.

A record of the performance of each animal at daily or other frequent intervals through the production cycle is not difficult to obtain. It gives the producer immediate information on the level of productivity at any given time and eventually for the whole production cycle, whether it be milk per cow, eggs per hen or gain in live weight per beef animal, sheep or pig.

Performance recording is perhaps easier to conduct with milking cows and laying chickens than it is with meat-producing animals. This is because it is easier to weigh or measure milk and count eggs and because these animals are managed in confinement to a greater extent.

Benefits to farmer

As an illustration of performance recording this article deals primarily with programmes for dairy cattle. How can the dairy farmer benefit from a record-of-performance programme on his farm?

He learns what each cow in the herd is producing each day, week or month, each lactation, and each year.

He can identify each cow and the young stock and learns to know them individually.

He has the production information on which to base his judgement of the level of feeding necessary to get

TABLE 1. United States: Performance testing identifies relation of milk production level to returns over feed costs in Holstein-Friesian herds

Average milk production	Cost of feed per cow per year	Cost of feed per 100 pounds milk	Income over	
			Cost of feed	All costs [1]
Pounds	..... *U.S. dollars*			
6 900	170	2.49	185	16
8 000	189	2.34	238	49
9 000	197	2.17	270	73
10 000	215	2.13	318	102
11 000	230	2.09	364	135
12 000	244	2.03	411	167

SOURCE: ARS 44-235, Vol. 47, No. 7, August 1971. U.S. Department of Agriculture.

[1] All costs equal twice the total feed cost.

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the greatest yield of milk most efficiently.

He can decide which cows are the most profitable and which should be eliminated from the herd.

He can judge which cows are not performing well and need special attention.

He can identify cows that are not breeding normally and knows their breeding history.

He can identify the best cows from which to keep offspring for herd replacements.

He has and can provide information from which to choose sires for use on the cows in the herd.

He has information on which to plan overall herd and farm management practices.

He has recorded information which will aid in selling producing stock.

Table 1 shows the benefit derived in returns over feed costs in relation to the level of production of cows in dairy herd improvement associations in the United States. As the level of production increases the cost of feed also increases, but the feed cost per 100 pounds of milk decreases while the income over feed and all costs goes up.

FIGURE 1. On this El Salvador farm the milk from each cow is weighed and a sample taken by the supervisor for analysis.

FIGURE 2. A dairy assistant takes a sample of milk on a farm in Mauritius.

What is required to performance test a herd

The herd owner must be convinced that performance recording is a good programme for him and be willing to do the required work or have it done on a continuing basis.

He needs to keep up-to-date information on each animal in the herd on a continuing basis. This includes (*a*) identification of each animal by name or number, including birth date; (*b*) date on which the cow is bred, the date of calving, and date of the last milking in each lactation; (*c*) date of birth, name and number of the sire to which the cow is bred.

For feeding information, he has to record the amount of feed, both concentrates and forage, fed to each cow on the day that the milk record

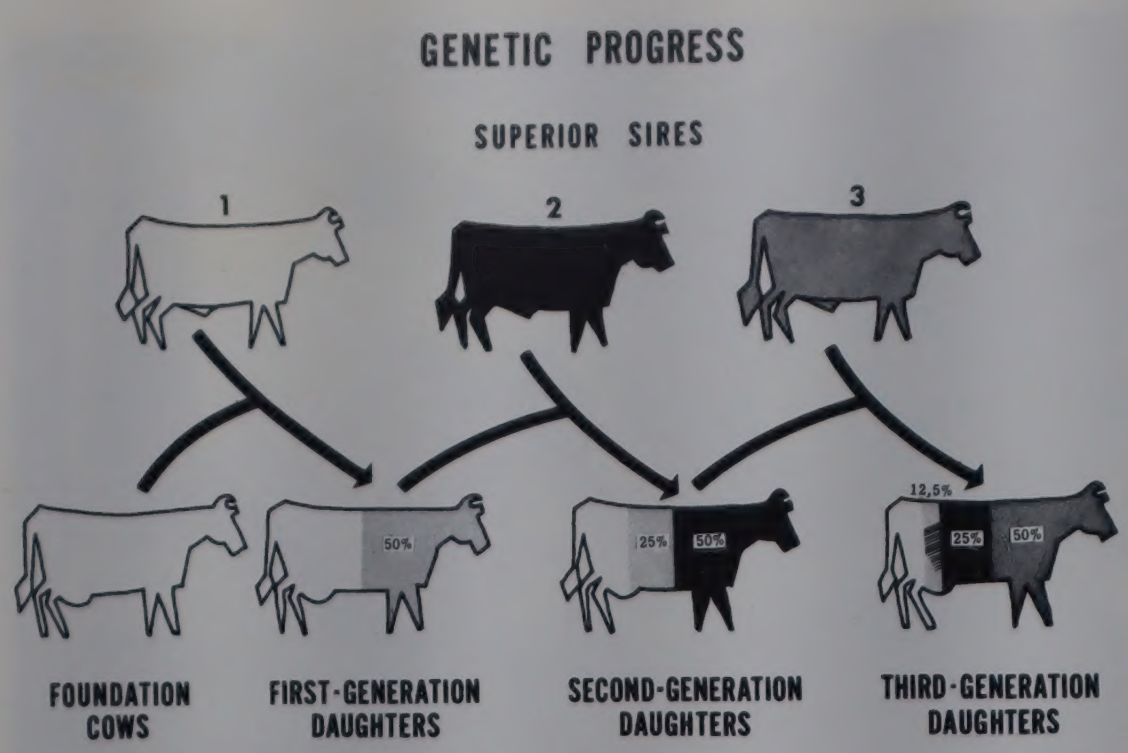

FIGURE 3. By keeping records and using superior bulls the performance and production of a herd can be improved.

is taken. If the cow is on pasture, this needs to be recorded for the period covered by the test. Records should be taken of the adequacy, kind and quality of the pasture, and the kind and quality of other feeds.

He must record other information relating to the condition of the cows, such as heat periods, illnesses, mastitis and other abnormalities to aid him in analysing production performance and in other management functions.

He should have all the information on each animal recorded on a current basis in a herdbook and available for his ready use.

How a recording programme operates

Recording programmes for dairy cattle are well developed in most countries where there are large and important dairy industries. These programmes have done a great deal to improve these industries.

The basic item in the recording programme is the measurement of the milk yield of the individual cows at regular intervals. This is generally done at monthly intervals. From this milk weight the yield for the month is calculated. This information is brought forward at each test period to give the total yield for the lactation or year.

In addition to obtaining the milk yield, the amount of butterfat produced must be recorded. The milk at each test period is sampled, the butterfat percentage determined and the yield of butterfat calculated and brought forward for the month, lactation, and year. The same is done for solids-not-fat and protein in some programmes.

There are several variations acceptable in record-of-performance programmes. A dairy farmer can conduct his own programme. In this case, all he has to do is weigh the milk as often as he chooses, daily or once a month for example, and calculate the production for the month, the lactation, and the year. Determining the butterfat, solids-not-fat or protein is not so easy, although some dairymen do it.

Record-of-performance associations

In areas where a number of dairy farmers are interested in recording, the usual practice is for them to organize a cooperative association. The officers of this association can then employ a supervisor whose job it is to conduct the testing of the members' herds. If the testing is on a once-a-month basis, a supervisor can test about 26 herds a month. While dairymen can do their own recording, the record information would be considered unofficial. When the testing is done by an impartial hired supervisor, the records can be accepted as official according to the rules set up by the association. In most countries, the programmes of numerous local associations are supervised and coordinated by government agencies and thus become nation-wide programmes. This has many advantages. For example, it provides a means for collecting records on cows from all associations and herds and using them to evaluate sires so that the best ones can be found and used more extensively for breeding to increase the genetic abilities of large numbers of dairy cows. This information is also useful for educational and extension purposes.

The supervisor, in addition to weighing and sampling the milk for butterfat analysis, has a number of other responsibilities. These are:

to determine butterfat or other analyses, if these are parts of the programme;

to calculate each cow's production for the period and to date, and enter this information into suitable herdbook forms and return them to the farmer;

to discuss this information with the herd owner and to advise him on his herd feeding, breeding, and management operations;

to enter into the farmer's herdbook other needed information such as

TABLE 2. Increases in net income due to consecutive years of recording [1]

Number of cows	Increases in income after recording for	
	6 years	10 years
	..... *U.S. dollars*	
30	77	128
50	716	1 194
80	3 132	5 220

SOURCE: J.D. McCaffree *et al.*, personal communication. Data in press for publication in *J. Dairy Sci.*

[1] After costs of testing have been paid.

TABLE 3. Three methods of performance recording, official and unofficial,[1] used in the United States

Official	Unofficial [2]	Unofficial [3]
Supervisor weighs milk	Owner weighs milk	Owner weighs milk
Supervisor weighs feed	Owner weighs feed	Owner weighs feed
Supervisor enters figures	Owner enters figures	Owner enters figures, including average butterfat for herd from milk check
Supervisor takes milk samples	Owner takes milk samples	
Supervisor handles forms	Supervisor picks up forms	Owner mails forms
Supervisor or central laboratory tests milk for butterfat	Supervisor or central laboratory tests milk for butterfat	
Computing centre calculates official records	Supervisor or central office calculates unofficial records	Central office calculates unofficial records
Supervisor eartags animals		
Breeding record is compiled		
Production records used in sire-evaluation programme		
Supervisor helps owner use records to improve his herd	Owner uses records to improve his herd	Owner uses records to improve his herd

[1] Variations of the unofficial plans to meet the needs of dairymen in particular situations are recognized. – [2] Owner takes samples. – [3] Owner weighs once a month.

identifications, freshening and dry dates, ages, breeding dates, etc.;

if feed recording is included in the programme, he develops this information on each cow and records it in the herdbook for the farmer's use;

with coordinated programmes of more than one association, he sends forward to the government agency, for example, completely identified lactation records of each cow;

he otherwise serves as a special adviser to herd owners.

In government-supervised and sponsored programmes, the local supervisor may be a representative of the government agency.

Organized testing programmes generally cost farmers money but they may be partially or totally subsidized by a government agency. In any event, it has been amply demonstrated in many countries that a recording programme is a good investment for dairy farmers.

Continuous testing over a period of time pays good dividends. This has been proved for dairy herds in New York state. Table 2 shows the increased benefits in returns from dairy herds of different sizes that have been on continuous testing programmes for six and ten years. The increase in net income shown per herd (after all costs were considered, including the cost of testing carried out by the local cooperative dairy herd improvement association) is based on a comparison with similar herds of the same size for which no recording programme was used.

The benefits increased with the years of continuous recording and were higher in the larger herds.

The National Cooperative Dairy Herd Improvement Programme in the United States has three general plans for recording. They are shown in Table 3.

Conclusions

The purpose of this article is to emphasize the need for and encourage the introduction of recording programmes for dairy farmers where none now exist. Those governments, agencies and individual educators interested in improving dairying in developing countries should give serious and immediate attention to this kind of programme. New programmes should be simple and adapted to local situations. They could start by recording milk production only, as in most developing countries less attention is given to butterfat content in the marketing system. As such programmes grow and develop they can merge into nationwide programmes of benefit to the whole dairy industry.

El Salvador has embarked on a production recording programme which has been adapted to local conditions and is being supervised and supported by the Livestock Division of the Ministry of Agriculture. This programme is having considerable success. Performance recording is also being started in some parts of India.

Further information on dairy recording programmes can be obtained from:

Dairy Cattle Research Branch, Animal Science Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland 20705, United States.

or Production Division, Milk Marketing Board, Thames Ditton, Surrey, England.

SUGGESTED READING:

Dairy cattle: principles, practices, problems and profits, by R.C. Foley *et al.*, 1972. Philadelphia, Pennsylvania, Lea and Febiger.

Articles for World Animal Review *are welcomed on animal health or production or animal products, especially when they refer to progress in developing countries. It is suggested that intending contributors first write to the technical editor, giving brief details or a summary of the proposed article.*

Milk production in Brazil

J.M. HALL*

With an area of 8.5 million square kilometres and a human population of nearly 95 million, Brazil is a country which for size and diversity of natural conditions is more in the nature of a continent. It is 60 percent larger in area than Europe, 10 percent greater than Australia and only 9 percent less than the United States.

The study of milk production in this country can be justified not so much on account of the technical means employed, which are generally the same as in most tropical and subtropical countries, but by the existence of a huge production potential which, if developed, could go far toward filling the national animal protein gap.

The national herd

In 1968 the Instituto Brasileiro de Geografia e Estatística (1970) estimated the Brazilian cattle population at 92.7 million, although the Ministry of Agriculture took only 63.7 million head as a working figure. For 1970/71 FAO (1972) quoted 97.3 million.

Cattle raising is practised throughout the country, but most of the animals are found in the more temperate region from Minas Gerais state southward, where 56.5 percent of the animals are on 17.5 percent of the land area. This is the most productive part of the national herd and supplies all the meat for export.

As regards breeds, the animals originally brought in by the Portuguese settlers were absorbed in the north and central part of the country by various strains of zebu (in Brazil called *gyr*, *guzerá* and *nelore*) imported at the beginning of this century and which today account for two thirds of the national herd. In the southern states this displacement took place rather more in favour of the European breeds, which can be identified in varying degrees of purity in the rest of the national herd. Friesian cattle, either pure or crossed, predominate in the principal peri-urban dairy districts and are the most suitable for efficient milk production.

If the figures for 1968 of 92.7 million head are accepted, then Brazil, with 8.3 percent of the world's cattle, produced only 7.03 million tons of milk in that year, or 1.9 percent of total world production. Moreover, Brazilian beef output in the same year amounted to only 2.2 percent of the world's total production. It seems, therefore, that the physical productivity of the Brazilian cattle herd ranges somewhere between one quarter and one fifth of the world's average livestock productivity.

It is estimated that about 37 percent of the national herd is cows, of which two thirds are milked. A fertility rate of the order of 50 percent would give 10 million lactations per year of 700 kg each, or 3-litre daily milkings for an average of 8 months. The milk consumption by calves may be taken as about 350 kg up to weaning at the end of lactation. Consequently, 10 million calves would consume the equivalent of 125 000 tons of butter, while the human population has to be content with the

FIGURE 1. Gyr-type zebu cattle on a small farm near São Paulo.

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FIGURE 2. Brazilian cattle being driven across the *sertão*. Two thirds of the national herd consists of various strains of zebu.

mere 25 000 tons produced in the country. It should be noted that milk production is greatest in the three southern states (20.6 percent of the production on 6.6 percent of the land area) and the four southwestern states (57.8 percent of the production on 10.8 percent of the land area). The other 15 states contribute only 21.6 percent of the milk production from 82.6 percent of the country's total area.

The production sector

In Brazil, milk is produced by a very mixed sector, consisting for the most part of small producers. A survey by the Associação Nestlé de Produtores de Leite (1968) showed that 90 to 96 percent of a total of 12 600 suppliers produced less than 144 litres per day. In Calcilandia (Minas Gerais) 51 percent of the 1 587 suppliers marketed less than 12 litres per day. Conversely, a survey by the author at Lins (São Paulo) in 1970 (Hall, 1971) showed that 66.5 percent of the milk producers each delivered more than 200 litres per day to milk plants.

The efficiency of milk production also varies considerably. Against the low average productivity of the national herd, the results of the Government's milk records for 1968 (Associação Paulista de Criadores de Bovinos, 1969), covering 6 000 cows spread over 260 farms, gave lactation yields in excess of 4 000 kg for Friesians; these were 72 percent of the animals recorded.

The level of management is not closely correlated with the size of the production unit; it is low both on smallholdings (*minifundios*), which account for 76 percent of the units and 12 percent of the land area, and on large estates (*latifundios*) which are 22 percent of the units and 84 percent of the land area.

The most intensive and economic milk production units are almost invariably family farms of intermediate size (up to 200 hectares) but this type of farm accounts for only 2 percent of the units and 4 percent of the area.

Economic importance

In 1968 the value of Brazilian milk production reached 1 630 million cruzeiros (about US$400 million). According to the same source (Instituto Brasileiro de Geografia e Estatística, 1970), milk that year ranked third in importance among agricultural products after beef (2 100 million cruzeiros) and rice (1 700 million).

Milk thus accounted for 24 percent of the value of the country's animal production, 8 percent of its agricultural output and 1.9 percent of the gross national product. In the same year the gross value of the beef and milk produced was 24.3 percent of the value of the cattle herd, assessed at 15 200 million cruzeiros, or 10.4 percent of the total agricultural capital invested in pastures, cattle, installations and equipment.

These figures show that despite

its importance for the national agricultural economy milk production yields a very low monetary return. In fact the main component of the producer's income lies in the continually increasing value of his land, which is considerable although milk production is of dominant importance in some states. In Minas Gerais, for example, which provides 33.3 percent of the nation's milk production, it accounts for 23.1 percent of the gross agricultural product and for 6.9 percent of the gross product of the state.

At the farm level, milk production is a regular source of income for the farmer which partly offsets the irregularity of his other agricultural activities.

Economics of production

It is difficult to estimate an average cost of milk production because of the wide variation in the production sector and in its level of management. However, Andrade (1969) established that the cost varied inversely with the production of pasture per hectare. In the sample studied, the deficit ranged from 2.8 percent of the average annual cost for 1 188 litres per hectare per year to 16 percent for 390 litres per hectare per year.

The producer is paid in accordance with a quota policy under which the official price is paid only for milk delivered during the dry season (May to September) and the "excess" produced during the rainy season is subject to the law of supply and demand. This Draconian policy of the processors has led to a relatively regular production; in São Paulo state, for example, it was estimated (Hall, 1971) that in June the processors were supplied with 64 percent of the volume delivered in December.

In 1969 the quota price paid to the producer who delivered a rigorously uniform output to the milk plant was 27.9 cruzeiros per hectolitre, the equivalent of about 7 U.S. cents per litre. For most producers, however, the price actually paid was only 50 to 60 percent of the quota price.

As regards credit, the Banco Central (1970) estimated the volume of credit for cattle farming at 1 020 million cruzeiros (US$220 million) of which 30 percent went to the dairy sector. Of this amount, which was one sixth of the gross value of production, two thirds were used to buy animals and the balance as working capital.

FIGURE 3. European breeds of dairy cattle on *gordura* pasture in the Paraïba valley.

Cattle feeding

According to Grossman (1965) Brazil had 97 million hectares of pasture and fodder crops for large livestock in 1965, which would amount to an average carrying capacity of 0.45 livestock unit per hectare. The productivity of these fodder crop areas ranges between 500 feed units (1 feed unit is equivalent to 1 kg barley) per hectare per year for the *campo cerrado*, the native vegetation that covers much of the country, and 10 000 feed units for a good crop of irrigated Napier grass (*Pennisetum purpureum*).

On the *campo cerrado* and on pastures of Guinea grass (*Panicum maximum*) and *capim gordura* (*Melinis minutiflora*), it is estimated that 80 percent of the dry matter is produced during the five-month rainy season (November to March).

The making of silage is developing, but it entails a level of capital investment beyond the reach of most small producers, who go on using the *capineira* (grassfield) of Napier grass or sugarcane (*Saccharum officinalis*) which is cut, chopped and fed in troughs during the dry season. The nutrient ratio (proteins:energy) of the ration is generally low in nitrogen, but some tropical legumes such as soybean (*Glycine* spp.) and *siratro* (*Phaseolus atropurpureus*) might solve this problem.

A mineral mixture based on sea salt, lime and bone meal is fed throughout the year in the cattle-raising areas.

It may be added that the irregularity of feeding causes seasonal weight losses of the order of 10 to 20 percent of live weight, which slow down the growth of young animals and lead to an energy waste amounting to 50 percent of the herd's meat and milk production.

Health controls and extension

Brazil has 12 schools of veterinary medicine, which turn out about 400 graduates per year. The country's 3 000 veterinarians are employed in administration (1 200), teaching (500) and the pharmaceutical and animal

feed industries. Field practice is virtually nonexistent.

The behaviour of cattlemen with regard to health control is such that prophylactic programmes are generally undertaken only for immediately fatal diseases (the anthraxes) or to forestall an irretrievable loss in economic value (foot-and-mouth disease). No action is ever taken against diseases of long-term economic effect (parasitism, genito-urinary ailments) or those with social implications (tuberculosis, brucellosis).

It is estimated that foot-and-mouth disease inflicts on Brazil an annual loss of the order of $100 million, or more than 10 percent of the gross product of cattle raising. A project of an estimated duration of 16 years for systematic vaccination costing $65 million and financed by the Inter-American Development Bank was launched in 1971.

In the extension field, dairy production is rather the poor relation in the *Casas da Lavoura* of São Paulo state and of the ABCAR (Brazilian Association for Rural Credit and Assistance) in the other states. The PLAMAN (Dairy Cattle Improvement Plan), a federal dairy agency, neglects extension work in favour of the industrial development of cooperative milk plants.

FIGURE 4. Typical farm in the central region of Minas Gerais. This mixed herd of 50 animals produces only 150 litres per milking.

The dairy industry

Only one third of the annual milk production in Brazil — 2.4 million of over 7 million tons — undergoes industrial processing. Of that third, 28 percent is converted into milk powder (70 000 tons), 25 percent into butter (25 000 tons), 20 percent is pasteurized (0.5 million tons), 15 percent is made into cheese (42 000 tons) and only 3 percent into condensed milk (20 000 tons). Apart from the Nestlé Company, which had a capital of 124 million cruzeiros in 1969 and was ranked the forty-second company in the country, the Brazilian milk-processing industry consists of a host of medium-sized and small private and cooperative units of no great economic importance.

This industry is characterized by extreme specialization (liquid milk, milk powder, butter and cheese), which does not always result in the best efficiency, especially as regards small enterprises. The disorderly establishment of plants leads to underutilization of their maximum working capacity and to violent competition among the major producers.

This situation explains why the ratio of the wholesale price of the major milk products to that of the raw material is: for milk powder — 23.3 in Brazil against 10.5 in Canada; for pasteurized butter — 24.2 in Brazil against 19.6 in France; and for mozzarella cheese — 19.2 in Brazil against 11.9 in Italy.

As the production capacity of the domestic industry has increased, imports of milk powder have steadily declined from 24 500 tons in 1966 (Instituto Brasileiro de Geografia e Estatística, 1970) to no more than 2 000 tons in 1969; but this is also due to less milk powder being available on the world market.

These figures do not imply that the consumption capacity of the population has been saturated; in 1969 daily per caput consumption was estimated (Passos, 1969) at the equivalent of 331 grams of liquid milk in central Brazil and only 147 grams in the rest of the country. FAO (1969) estimated the daily per caput consumption of proteins at 66.5 grams, of which only 18.5 grams were of animal origin.

Outlook

If the technology of Brazilian cattle production could be raised to the average world level, the current volume of dairy production could be increased by a factor of 4 or 5. Moreover, the utilization of now idle lands could raise this factor to 10. However, the average growth rate of dairy production between 1958 and 1969 was 5 percent per year, which is only slightly higher than the rate of population growth. Furthermore, dairy production is developing in states where agriculture is most backward, such as Minas Gerais; in São Paulo, on the other hand, production declined from 1.4 million tons in 1964 to 1.3 million tons in 1969. In the face of the disparity between the production potential and actual trends, what remedial measures should be suggested?

The practice of technical assistance

FIGURE 5. Direct sale of raw milk in a small town in Minas Gerais.

over the last two decades indicates that the technological level on which any agricultural product is produced is governed by the "response" of the farmer to a set of institutional, social and economic factors. Accordingly, these factors have to be acted upon before production can be stepped up. In the case of Brazil, stepping up dairy production would entail:

1. An effective reform of the land-tenure system. As the Associação Nestlé de Produtores de Leite (1968) showed in a sample of 820 suppliers, dairy productivity per hectare of pasturage is inversely proportional to the total area of the unit, ranging from 1.8 litres per hectare per day on farms of less than 121 hectares to 1.1 litres for 121 to 300 hectares, and to 0.8 litre on farms of more than 300 hectares.
2. The setting up of a milk marketing board in the Federal Government to implement a national programme for production, to rationalize and coordinate the industrial infrastructure, and to put the market for milk and milk products in order, possibly by resorting to the distribution of these products free of charge to the more vulnerable segments of the population.
3. The implementation of a really cooperative programme of production that would not be limited to marketing, but would also channel credit, provide for technical assistance and proceed to the communal organization of operations requiring sizable capital investments (such as fodder production) or technical control (such as calf rearing).

FIGURE 6. Different grades and packing of milk in a São Paulo supermarket.

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A model for improved milk production in India

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During its second five-year plan (1956-61) India was producing about 19 million tons of milk per year which provided approximately 140 grams of milk per person per day. At present the milk production is estimated to be around 24 million tons a year thus giving an average daily supply of 110 grams per person. The nutritional requirements of 250 grams of milk per person per day (quoted as desirable in the report of the [Indian] National Commission on Agriculture) calls for an annual production of about 55 million tons in 1980, when it is estimated the population will be 650 million. These figures show the magnitude of the task of increasing production.

Milk output during the last decade has not increased as much as it should have done. A study of the reasons clearly indicates that as long as it is not developed on commercial lines, assuring adequate returns to farmers on investments made, a significant improvement in milk production is not possible. Investigations conducted in different parts of the country show that the cost of producing a litre of milk under the existing rural conditions is almost equal to the price paid for it by the consumer. In most cases the margin of difference is no more than Rs.0.10 to 0.15 (US$1 = approximately Rs. 7) per litre. This narrow margin is not adequate for commercial milk production. A reduction in the cost of output is therefore necessary, as there is very little likelihood of raising the price of milk to the consumer, which is as high as in many dairying countries.

Economics of milk production

Investigations in India have shown that the two essential components for reducing costs are:

(*a*) high-yielding dairy cows, and
(*b*) high quality succulent fodders to supply the nutrients required for milk production at a lower cost.

Level of milk yield and cost of production

In a recent study undertaken at the National Dairy Research Institute at Karnal, the cost of milk production in a Sahiwal herd, averaging 2 200 litres of milk per cow per lactation, was Rs.1.10 per litre, and for a crossbred herd, averaging 3 000 litres per lactation, the figure was Rs.0.72. At the urban retail price of Rs.1.20 per litre, the cost of milk production from the crossbreeds was only 60

FIGURE 1. Crossbred cows at the National Dairy Research Institute, Karnal, India.

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TABLE 1. Costs of maintenance and milk production for two Indian dairy breeds

Production level per calving interval	Costs			
	Sahiwal		Crossbred	
	Cow per day	Milk per litre	Cow per day	Milk per litre
Litres	..... *Rupees*			
801-1 200	4.24	1.77	4.02	1.40
1 201-1 600	4.54	1.41	4.33	1.10
1 601-2 000	4.82	1.18	4.66	0.95
2 001-2 400	5.00	1.06	5.01	0.81
2 401-2 800	5.32	0.96	5.30	0.74
2801-3 200	5.23	0.97	5.48	0.71
3 201-3 600	5.31	0.92	5.78	0.66

percent of the consumer price whereas in the case of purebred Sahiwal, considered to be the best Indian dairy breed, it was 92 percent. The costs of milk production for various levels of lactation yields in both herds are given in Table 1. These figures show that with better lactation yields the costs can be brought down to 50 percent of the retail price.

Production of high-yielding cattle

With heritability as low as 0.3, and the average production of selected groups of the better yielding Indian cattle being 1 000 to 1 500 litres of milk per lactation, attempts to increase this to a remunerative level of around 2 500 litres will take about 25 generations of selection, that is, 150 years. By using bulls from the high-yielding Indian dairy breeds such as Sahiwal, Tharparkar and Red Sindhi on other and better zebu cattle, production can be increased in four generations of grading to 2 000 litres per lactation. This will take about 25 years. Yet it will not reach a remunerative level of milk production. For adequate net returns in commercial dairying the only alternative is the introduction of exotic inheritance into zebu cattle to produce a new strain of dairy cattle in India which would average 3 000 litres per lactation. Such a strain already produced in the country in modest numbers has one-half to three-quarters exotic inheritance from one or two exotic breeds, mainly Jersey or Holstein-Friesian. At the National Dairy Research Institute, a strain of half Brown Swiss and half Sahiwal, named Karan Swiss, has been produced which averages 3 000 litres of milk in the first lactation and about 3 200 per lactation when all ages are put together. A few crossbred cows of the Institute are shown in Figure 1.

Economic supply of nutrients

The nutritional requirements of dairy cattle for maintenance, milk production and pregnancy are recommended in terms of kilograms of digestible crude protein and kilo-

TABLE 2. Expenditure and income of family dairy farm in India

Capital and recurring costs, and income	Total cost	Annual depreciation	Annual cost
	Rupees	*Percent*	*Rupees*
Capital expenditure			
Livestock:			
20 cows at Rs. 3 000 each	60 000	15	9 000
Building costs:			
Shed 40 ft × 15 ft at Rs.10 per sq ft (Rs.6 000)			
Paddocks and boundary wall 40 ft × 35 ft at Rs.2 per sq ft (Rs.2 800)			
Well and pumphouse (Rs.4 000)			
Total building costs	12 800	10	1 280
Equipment:			
Electric motor for pumping water, chaff cutter, cans, farm machinery (including bullock cart)	3 500	20	700
TOTAL CAPITAL EXPENDITURE	76 300		
Interest on capital investment at 9 percent			6 867
Recurring expenditure			
Seed per hectare	400		
Fertilizers per hectare	850		
Total for 1 hectare	1 250		
Total for 2 hectares			2 500
Concentrates, 134 quintals at Rs.50 per quintal			6 700
Labour: 4 labourers at Rs.3.50 per day each			5 100
Irrigation and cultivation			2 000
Miscellaneous expenditure			2 000
Interest on annual investment			1 200
TOTAL ANNUAL EXPENDITURE			37 347
Income			
The average lactation per cow is 3 000 litres with a calving interval of 15 months. For every 15 months, 20 cows will yield 60 000 litres of milk. Therefore, for 12 months, the yield of milk would be 48 000 litres, which at Rs.1 per litre will produce an income of Rs.48 000			48 000
TOTAL EXPENDITURE			37 347
NET RETURN			10 653
NET RETURN PER HECTARE			5 326

FIGURE 2 (left). Summer crop of maize and cowpeas.

FIGURE 3 (above). Winter crop of berseem.

ALL PHOTOS: NATIONAL DAIRY RESEARCH INSTITUTE, INDIA

grams of total digestible nutrients per day. These nutrients can be supplied in most cases through high quality fodders. For high-yielding animals a little supplementation with a concentrate mixture (made from grains and by-products) will be necessary.

In large areas of India during the summer and monsoon months two to three crops of a fodder of maize and cowpea mixture can be grown. A cow consuming 40 to 45 kg of this mixture will have its nutritional requirements met for maintenance and for 4 to 6 kg of milk per day. Generally a high-yielding animal, averaging 3 000 litres of milk per lactation, will need an additional 2 kg of concentrate mixture per day to meet its full nutritional requirements during this period. In the colder months a good crop of berseem and mustard or oats and mustard can be grown. This meets the nutritional requirements of a cow for its maintenance and for 6 to 8 kg of milk per day. During this season a concentrate supplement of 1 kg per day will be adequate to meet the complete nutritional requirements of the cow.

Economics of the project

A remunerative dairy enterprise has been established with 20 cows maintained on two hectares of land by one family. Details are given in Table 2.

Fodder cropping programme for 20 high-yielding cows

As shown by the demonstration farm at the Institute a two-hectare plot of fertile loam soil in the Indo-Gangetic plains, with adequate subsoil water available for irrigation, can provide all the succulent fodder necessary for 20 cows. The two hectares are divided into small plots of one quarter of a hectare each, and during the summer and monsoon season a plot is sown each week with the mixed maize-cowpea seed. Each quarter-hectare plot provides all the fodder required for the 20 cows for a week and the crop is ready for cutting within 50 to 60 days of sowing. The first sowing is done in March-April, the second in May-June and the third in July-August. The last harvest of the summer crop is taken at the end of September at which time the winter sowing of berseem-mustard and oats-mustard is made. The first cutting of berseem and mustard is made in 60 days, and thereafter every 20 days. In the case of oats and mustard, two cuttings are made between December and March. Some of the surplus fodder produced during the winter is converted into hay or silage to meet any marginal deficiencies that may occur between summer and winter.

The above cropping programme will provide 150 tons of green fodder per hectare per year. Figures 2 and 3 show a summer crop of maize and cowpeas and a winter crop of berseem.

In this region hybrid or composite

varieties of maize are used, and cowpea varieties FOS-1, FOS-10, K-397, FS-146, Russian Giant or RS-9. Very good yields of berseem are obtained by using two parts diploid and one part tetraploid seed mixed together. Good yields of oats have been obtained by using Kent, Fulgham, Brunker, Weston, Green Mountain, Algerian and FOS-1/29 seeds.

For a good mixture of maize-cowpea, 40 kg maize seed and 15 kg cowpea seed are broadcast per hectare. For this crop, 40 tons of farm manure, 60 kg nitrogen, 30 kg P_2O_5 and 20 kg K_2O per hectare give very good yields. All nutrients are provided at sowing time except half the nitrogen, which is applied at three to four weeks of growth.

For berseem-mustard, the broadcast seed rate is 20 kg diploid plus 10 kg tetraploid plus 2.5 kg mustard per hectare. A good mixture of berseem and mustard needs 20 kg nitrogen, 60 kg P_2O_5 and 30 kg K_2O per hectare to be broadcast at sowing.

For oats-mustard, a broadcast mixture of 10 kg oats and 2.5 kg mustard per hectare is adequate. Sixty kg nitrogen, 30 kg P_2O_4 and 20 kg K_2O broadcast at sowing supply sufficient nutrients.

Housing

Cattle housing in most parts of India need be only very simple, since the winter is mild and the rainfall medium, with severe heat in the summer. Such a climate calls for open structures allowing plenty of air movement to keep the heat stress to a minimum. A system of loose housing is best for these conditions and is also labour saving. For a herd of 20 cows a good system has been tried, consisting of a roofed shed 40 ft × 15 ft (about 12.5 m × 4.5 m). Along the 40-ft length on one side is a 2.5-ft (0.75-m) wide manger, with a water trough at one end. The remaining 12 ft. (3.75 m) of the 15-ft (4.5-m) covered space is concreted and slopes away from the manger. There is an open paved area behind measuring 40 ft × 35 ft (12.5 m × 10.75 m) surrounded by a 5-ft (1.5-m) wall with a gate, as shown in Figure 4.

FIGURE 4. Open housing with manger, water trough, yard and surrounding wall.

Raising young stock

A sizable component of the cost of milk production per litre is the share of the cost of raising a young heifer until her first calf. In the National Dairy Research Institute demonstration unit, depreciation on 20 cows per year is calculated at Rs.9 000. With an annual production of 48 000 litres this works out at a cost of Rs.0.18 per litre. Investigations showed that at present it costs from Rs.2 000 to 2 500 to raise a calf from birth to first calving. This cost can be kept low by not giving calves whole milk and feeding them on skim milk from the time they have reached two months of age. A feeding schedule including calf starters is given in Table 3. This schedule is for calves with birth weights averaging 30 kg.

TABLE 3. Feeding schedule for calves on calf starters

Age	Whole milk	Skim milk	Calf starter
Days	..... *Kilograms*		
6–7	2.75	—	—
8–14	3.25	—	—
15–21	2.75	1.00	0.10
22–28	1.75	2.00	0.20
29–34	1.00	3.00	0.30
35–42	0.50	3.50	0.50
43–56	—	3.50	0.75
57–84	—	2.50	1.00
85–112	—	0.50	1.25
113–140	—	—	1.75
141–182	—	—	2.00

Conclusions

India is planning a massive programme to eradicate rural poverty. Dairying is one of the industries which can provide remunerative employment to rural labour and help raise productivity. The National Commission on Agriculture has recommended having 4 million farm families in such a scheme. If each family keeps three crossbred cows, there will be 12 million crossbred cows producing 24 million tons of milk a year, as much as 70 million zebu and buffalo cows are now producing per year. In addition to bringing prosperity to 4 million families, another 4 million rural labourers will be provided with employment.

More concentrates and less roughage for ruminants

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The expansion of animal production is a goal in many countries but the problems associated with increased livestock productivity are great, especially in the case of cattle. Adequate nutrition is one of the major limitations and this article discusses a rather new approach to feeding cattle and other ruminants in regions outside the temperate zone.

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Types of feed

Programmes for livestock expansion have been based almost exclusively on forage production because grains and similar crops have always been needed for direct consumption by man. However, if surplus grains or release of cropland in the developing countries are envisaged, there is need to consider the relative efficiency of producing forage crops for livestock compared to more concentrated feeds.

Concentrates have a number of advantages over forages for intensive production by ruminants in spite of the well-known inefficiencies of ruminants as feed converters compared with single-stomach animals. These advantages have caused a substitution of forage by cereal grains for feed-

FIGURE 1. Feeding farm-grown hay or silage to dairy cows may make the best use of the feed produced on the farm but does not necessarily lead to the most efficient milk production.

PHOTO: COLORADO STATE UNIVERSITY

FIGURE 2. System 1: Cattle seek food in an arid transhumance area (Senegal).

ing dairy and beef cattle in Europe and North America. The combination of concentrates and non-protein nitrogen (NPN) to satisfy protein requirements has great potential for ruminants. The possibilities for a livestock enterprise based on concentrate feeding should be considered seriously by those countries in the mid-latitudes that are interested in the expansion of cattle or sheep production. Moreover, labour-intensive crop production combined with animal production offers the potential for increasing rural incomes and rural employment.

FIGURE 3. System 2: Cultivating a paddy field with a buffalo-drawn harrow (Burma).

The green revolution

The spectre of widespread famine in the developing countries has receded — at least for the present. As a result it has been possible to give more consideration to the protein content and protein quality of national diets. There is a great desire for protein foods and especially for animal proteins among all peoples. The elasticity of demand is very high even at low average incomes, perhaps approaching 1.0 for meat. Demand implies money to buy, whereas desires are perhaps best described by Blaxter's term, "dietary aspirations" (Blaxter, 1969). Although calorie intake is still too low in many countries, the green revolution has raised the hope that man's needs for calories may eventually be met. What is needed now to fill the protein gap and satisfy dietary aspirations is a red and white revolution; a technology to revolutionize the production of meat and of milk.

Types of livestock production

The developing world has the majority of the world's livestock (over 60 percent) but these yield only about 25 percent of the world's supply of animal protein. At the risk of oversimplification, systems for ruminant animal husbandry can be divided into four main groups.

1. *Extensive livestock operations*, including nomadic, transhumance, and ranching, where the features are little or no feed obtained from cultivated land, low labour requirements, and minimal skills.
2. *Settled peasants*, many on irrigated land, who raise some livestock which subsist almost entirely by scavenging what man cannot or will not eat himself. Little or no arable land is used to produce feed directly for the animals, which are tended by those unable to do heavier work.
3. *Mixed crop and livestock farming*, where arable land is used for pasture, hay, root crops, and some cereals. Labour require-

ments and skills are high and are generally provided by the operator and his family.

4. *Intensive animal production*, featuring large units, high capital investments, and low labour requirements, dependent on cereals and a variety of chemical products for feed.

Livestock production in the developing world falls almost exclusively into either the first or second group while the systems described in the third and fourth groups are found mostly in the developed countries. The third group, the family livestock farm, is very rarely found in developing countries. In fact, Smith (1971) has related the lack of agricultural development in Latin America to the fact that the family type of livestock farming has never been able to develop there because of the prevailing land tenure system. The family farm with a mixed livestock, forage, and row-crop production was developed in the humid temperate zone and provided relatively good incomes for a large number of farm families.

Agricultural planning in developing countries has generally recognized the desirability of the family farm which is, or has been, the backbone of agriculture in western Europe and North America. A labour-intensive agriculture of this type yielding products of high value is greatly to be desired in many countries. The current trend, however, in the United States and to a lesser extent in Europe is toward specialization in crop production or one type of livestock production, that is, tending toward the fourth system described above.

PHOTO: FARMERS WEEKLY, LONDON

FIGURE 4. System 3: Dairy farming and field crop production (England).

High versus low quality feeds

Development programmes for livestock production have emphasized forage production for a number of reasons, but perhaps mainly because it was the basis of livestock production in the developed countries from which the experts on animal production came. Equally important considerations are that ruminants evolved and reached their present ecological position by their ability to utilize coarse forage and the fact that ruminants make less efficient use of grains than nonruminants. Blaxter (1969) has shown, however, that in the more northerly parts of the temperate zone, grass and beef production may be more efficient than cereal production.

Forage crops and ruminant animal production have been considered inseparable although Preston and Willis (1970) have challenged this concept and presented arguments for using feed energy sources which

FIGURE 5. System 4: Highly organized beef cattle feedlot, with associated feed mill (United States).

PHOTO: COLORADO STATE UNIVERSITY

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FIGURE 6. Lambs being fattened for market on feeds containing a high percentage of grains (United States).

can be produced more efficiently in the tropics, where the climatic conditions are less favourable for the growth of quality forages (Payne, 1966).

There are many reasons for the low productivity of animals in the tropics and subtropics — political, economic, social, medical and climatic — but the most important according to McDowell (1968) is poor nutrition. It is the purpose of this article to explore some of the nutritional limitations imposed by feeding systems dependent on low quality forages. The nutritional implications as they relate to protein and energy are outlined below.

1. Low quality high-fibre forage means low energy and protein intake which results in a slow growth rate and a long time to reach either puberty or market weight. The result is that far too high a proportion of the feed energy is used to maintain the animals.
2. Maximum intake of low quality forage is restricted by its slow rate of digestion. Even though the supply of such forage is unlimited, the energy intake per animal will be limited.
3. A high-fibre feed results in a greater percentage of the feed energy being wasted as body heat. Animal heat production should, of course, be minimized under conditions of high environmental temperatures.
4. Low quality high-fibre forages are normally low in protein, especially in the tropics.
5. Protein is the most expensive feed ingredient and although urea or other NPN sources can correct the protein deficiencies of highly digestible feeds, NPN is generally ineffective as a supplement to high-fibre feeds.
6. The digestible energy of forage is used less efficiently by ruminants than the digestible energy from concentrate feeds for reasons which are not yet well understood.

The advantages of feeding concentrates over low-protein high-fibre forages are that animals can consume more feed, digest more of the energy, utilize the energy more efficiently, produce less heat per unit of feed and utilize more NPN. The result is that animals grow faster and reach market weight or puberty earlier with a potential for great savings in feed for maintenance. McDowell (1968) has concluded that the only successful way to select animals which are adapted to tropical environments is on the basis of their production under the conditions in question. Such selection could best be made by feeding animals for maximum production under the given environmental conditions.

The advantages listed above are among the reasons (combined with low grain prices and ease of mechanical handling) which have resulted in the trend in the United States to feed the maximum amounts of concentrates and the minimum of forage necessary for rumination and health in beef and dairy production.

Are coarse forages necessary?

The idea prevails that developing countries must go through the intermediate steps followed in the United States — from all forage to forage supplemented with grain — rather than straight into a system based on concentrate feeds. There is a feeling that it is wrong to give ruminants feed which other animals could consume because the ruminant is able to utilize coarse forage. If ruminants are confined to roughage feeding or scavenging, all the limitations listed above must be faced and little improvement in productivity can be expected without a massive change in the quality of tropical forages — and there is little indication that such a breakthrough is imminent. In some quarters it is suggested that livestock selection can provide animals that are more efficient in the use of forage, but the prospects seem unlikely if they are based on current knowledge of rumen physiology and digestion.

Feed conversion efficiency of ruminants

The numerous advantages of highly digestible feeds enumerated above might well be considered in planning for animal production programmes involving ruminants, but plans based on feeding cereals or concentrates must face even greater resistance from

those who question the wisdom of promoting animal industries. The argument is heard frequently that ruminants use grains or highly digestible feeds less efficiently than non-ruminants such as poultry and pigs. The statement, however, is not true for milk production (Reid, 1970; Holmes, 1970). Milk is produced equally or more efficiently than pork, eggs, or broilers. Beef and sheep meat production, however, is a relatively inefficient process.

There are many ways of expressing the efficiency of animal production (Blaxter, 1969; Ward, 1968). One measurement of efficiency is obtained by comparing the energy intake with the energy of the product (milk, meat) and some prefer to calculate protein efficiency in the same way because animal products are valued primarily for their protein content.

The protein efficiency of ruminants, however, has less relevance because the ruminant can utilize low quality (and low cost) protein or even a large percentage of its protein requirements as NPN. Thus ruminants have a tremendous advantage in not requiring expensive protein and use should be made of this advantage. For this reason, the efficiency of ruminants is better expressed in terms of energy intake per unit of protein produced (Blaxter, 1969). Animal efficiency, however, might better be described in terms of energy intake per unit of saleable or edible product because the fact has to be accepted that "dietary aspirations" and income elasticity are such that animal products are consumed for reasons of palatability and social status rather than for their nutritive value. Regardless of the measure of efficiency used, the feed needed by the nonproductive members of the herd (young, mother cows, bulls) must be included in the calculation. This is a significant part of the feed requirement for any livestock enterprise, especially where the first calf may be produced at four years or later and the calving percentage may be only 40 to 60 percent.

What should be the approach to improving efficiency of animal production in developing countries? The success of livestock farming in the temperate zone was based on grass, but this does not necessarily mean that livestock enterprises with similar economic and social advantages could not be developed, based on other feeding systems. It is often thought that concentrate feeding is and must be associated with large size, large capital investment and minimal labour requirements. Because this has been the development in the United States does not mean that concentrate feeding and large capital investment are necessarily linked together. There appears to be no reason why, on small family farms, concentrates cannot be produced and fed to fattening or milk-producing animals. Preston and Willis (1970) have demonstrated that sugarcane can be used for this purpose. The possibilities in Venezuela have also been pointed out by González and Capriles (1970).

If land can be spared for livestock, the productive capacity should be exploited to the maximum, which will in many areas mean producing feeds other than forage. Intensive livestock operations based on labour-intensive feed crops may assist in solving one of the major social problems in developing countries, rural unemployment. Expanded livestock production can also contribute to earning foreign exchange, another severe problem for many countries. Unlike some other major agricultural products which are in surplus supply, demands for meat have been rising more rapidly than supply, and as they appear likely to continue to increase, the amount moving in international trade may also be expected to increase. This obviously does not solve any nutritional problems unless a part of foreign exchange earnings is used to purchase cheaper protein supplements.

Cost of meat and milk production

In answer to the criticism that meat and milk are inefficiently produced and too expensive for the poorer classes of people, one can only agree that this will be generally true in any country. On the other hand, as incomes rise, people do buy more meat and milk, both because they like these animal products and because they are nutritionally valuable. However, the criticisms of animal production programmes for developing countries have been well summarized by Morley (1969) and it is well to consider his warnings about blindly recommending animal production schemes. Because animal products are prestige foods, and may even be considered luxury foods, it is reasonable to argue that those countries with widespread protein deficiency should be encouraged to commit their resources to the development of cheaper foods that can correct nutritional problems.

However, in the long run, any policy designed to encourage consumption of unfamiliar and cheaper foods of lower prestige value seems unlikely to succeed until the behavioural scientists and advertising profession develop more effective techniques than are now available.

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Citrus by-products for animal feed

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Of about 70 species of citrus only two, the grapefruit (*Citrus paradisi* Macf.) and the sweet orange (*C. sinensis* Pers.), are industrially processed on a large scale, mainly for juice or sections. The by-products are peel, rag (the stringy axis and white fibrous membrane) and — depending on the method of processing — citrus molasses and citrus seed meal. Another citrus fruit, the lime (*C. aurantifolia* [Cristm.] Swingle), is of importance in some countries where it is processed to yield lime oil and lime juice. The method of processing this fruit is different from that for grapefruit and sweet oranges and is dealt with separately.

In many countries the citrus industry supplies feed for animals from the large quantities of by-products. The harvest usually coincides with the dry season when grass is scarce. This article is an attempt to bring together available information on ways of utilizing the surpluses and industrial by-products.

Whole citrus fruits

The grass in citrus orchards is usually not grazed as mature cattle could reach the fruits on the trees. Fallen grapefruit and oranges, as well as lemons, are eagerly eaten and these, together with surplus and unmarketable fruits, can be used for feeding cattle. Intakes of up to 40 kg per day have been reported with no apparent harmful effects (Volcani, 1956) apart from the danger that the whole fruit may obstruct the oesophagus. The fruits should therefore preferably be cut before feeding. This can most easily be done by passing the fruits across a frame on which parallel sharp knives or saw-blades are mounted a few centimetres apart.

There are conflicting views as to whether or not fresh citrus fruits will affect the taste of milk. It seems that grapefruit in particular should be offered to dairy cows only soon after milking in order to avoid flavoured milk. Citrus fruits have sometimes a beneficial effect on milk yield and may also temporarily raise the butterfat content (Volcani, 1956). Attention should be given to protein and mineral supplements when feeding fresh citrus products because they provide little protein, calcium or phosphorus.

Pigs prefer oranges and tangerines to grapefruit and the free choice feeding of citrus fruits, together with a protein supplement, has given good results with these animals (Gohl, 1970).

Fresh citrus pulp

When oranges or grapefruit are processed for juice or sections, 45 to 60 percent of their weight remains in the form of peel, rag and seeds (U.S. Department of Agriculture, 1962). This waste is palatable to cattle and mature cows will, when they are accustomed to the feed, consume about 10 kg per day. Because of the high water content and the perishable nature of the waste, economically it can only be used close to the processing plant. The feed is rather difficult to handle, will ferment and sour quickly, and can be a fly-breeding nuisance if allowed to spoil. The large amounts which are available during the harvesting season can be ensiled for year-round feeding, but as citrus pulp is rather moist the silage loses up to 40 or 50 percent of its fresh weight during fermentation (Volcani, 1956). It is more advantageous to mix the fresh pulp with partially dried grass or with legumes which cannot be successfully ensiled on their own. The liquid lost from the pulp will then be absorbed by the green fodder. The silage has a pleasant odour and is readily eaten by cattle. Citrus pulp silage has a much higher weight per volume than that of grass or maize silage and therefore silos in which it is to be placed should be more strongly reinforced. This problem does not apply to trench silos.

Citrus pulp can be easily ammoniated. The simplest method is to load the waste into a long polyethylene sleeve and let ammonia gas from a "bomb" (ammonia under compression in a steel cylinder) into one end. The progress of the ammonia is easily followed as it turns the pulp brown and heats it. When the ammonia reaches the other (open) end of the sleeve the gas is turned off and the excess ammonia is aired off from the pulp before it is fed to cattle. The added nitrogen is insoluble in water and is stably bound to the organic matter, apparently combining with the pectin. The crude protein digestibility of ammoniated citrus pulp is about 60 percent (Volcani and Roderig, 1953).

Dried citrus pulp

To increase the usefulness of citrus pulp it can be preserved by drying, but direct drying is difficult because of the slimy consistency of the waste. It has been found that the hydrophilic nature of the pectin in the waste can be destroyed by adding

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TABLE 1. Composition of citrus feeds

	Source of information	Dry matter	Nutrient composition of dry matter						
			Crude protein	Crude fibre	Ash	Ether extract	Nitrogen-free extract	Calcium	Phosphorus
			Percent						
Whole fresh grapefruit	Israel	12.7	7.0	8.7	3.9	2.4	78.0	0.79	0.16
Whole fresh orange	Israel	12.8	7.8	9.4	4.7	1.6	76.5	0.47	0.23
Fresh grapefruit pulp	Israel	17.9	6.7	10.6	3.9	1.7	77.1		
Fresh orange pulp	Israel	16.1	6.8	6.2	3.7	1.9	81.4	1.30	0.12
Fresh lime pulp	Trinidad	18.3	7.8	16.9	3.6	5.0	66.7		
Silage of grapefruit pulp	Israel	19.2	7.3	13.0	4.2	2.0	73.5		
Silage of orange pulp	Israel	19.6	7.7	14.3	5.1	2.6	70.3	1.38	0.10
Silage of lime pulp	Dominica	23.0	10.6	21.0	9.5	6.4	52.5		
Dried citrus pulp	Trinidad	91.8	6.9	13.1	7.1	2.8	70.1		
Dried citrus pulp	United States		8.1	11.4	5.5	3.9	71.1		
Citrus molasses	United States	71.0	5.8	0.0	6.6	0.3	87.3	1.13	0.08
Citrus seed meal	United States	85.0	40.0	8.8	7.0	6.7	37.5		

lime. The machinery for drying is expensive and the process is economical only where large amounts of waste accumulate. The first step in the drying process is the addition of 0.5 percent lime to the shredded skins to neutralize the free acids and to bind the fruit pectin. There are then two methods of further processing:

1. The excess moisture is removed in a press before drying the pulp. The press liquor may be discarded, or concentrated under reduced pressure to 60 or 70 percent dry matter and used as animal feed (citrus molasses).
2. The entire wet material is dried directly in a rotary drier. This method is practical in areas with access to natural gas or other low-cost fuels.

Dried citrus pulp that has been pressed before drying is somewhat lower in nitrogen-free extract. Only the contents of ash, fibre and water are consistent, while protein, fat and nitrogen-free extract vary according to season, the proportions of oranges and grapefruit used, and also the quantity of seeds in the fruits.

Citrus pulp is the most versatile of the citrus feeds; it is palatable, rich in nutrients, easily mixed with other feed ingredients and exerts a mildly laxative effect. It can be stored for all-year feeding and deteriorates less in storage than many other feeds. Rodents and birds are not particularly attracted to it. Dried citrus pulp is slightly hygroscopic and should therefore be stored in as dry a place as possible.

The major disadvantages of this feed — bulkiness, its varied particle size and its characteristic of "bridging over" discharge outlets of storage bins — can be overcome by pelleting. The process used at present for pressing feeds into pellets requires a high consumption of power and has a low plant capacity, factors which tend to make pellets more expensive than other forms of feed. Only citrus pulp intended for the rapidly growing export market is now pelleted. A new method that takes advantage of the fact that wet citrus pulp approaches a semiplastic state under pressure has been developed (Shoemyen, 1969): the pulp (not treated with lime) is mixed with molasses and extruded under low pressure in a continuous process.

No difference is made between dried pulp from oranges and grapefruit. Because of the method of processing it is a good source of calcium, but it contains little phosphorus. Due to this imbalance it is necessary to ensure that calcium and phosphorus levels are adequate and are of the right ratio when dried citrus pulp is included in the diet.

FIGURE 1. Processing and canning of tropical fruit in Peru.

FIGURE 2. Adding citrus molasses to maize silage in Kenya.

In some cases cattle grazing on phosphorus-deficient land and being fed the pulp in large amounts have become ill because of an improper calcium to phosphorus ratio. As citrus pulp has a low vitamin A content, green leafy roughage should be an important ingredient in rations with high levels of the pulp.

Dried citrus pulp has been used as the main energy source for beef cattle and heifers, and up to 45 percent has been used in calf rations. However, the pulp should not be used at high levels for milking cows as milk production tends to decrease. Digestibility trials with sheep show that its digestibility decreases when citrus pulp is included at levels in excess of 30 percent of the ration (Devendra, 1971). In a review of 73 experiments (Kirk and Koger, 1970) no significant differences in gain or energy conversion between steers fed rations of maize or of dried citrus pulp were found when each was combined with adequate protein and other essential nutrients. A positive correlation ($r = 0.46$) was found between percent of energy from dried citrus pulp and dressed carcass percentage. In other experiments (Boucque *et al.*, 1969) with high-energy diets given to young bulls, where dried citrus pulp replaced dried sugar-beet pulp on a weight-for-weight basis, no significant differences were found with respect to dry matter intake, feed conversion, daily gain or carcass quality.

Substances toxic to swine and poultry are present in dried citrus pulp that includes seeds, and the high content of fibre also restricts its use in pig and poultry rations. However, dried citrus pulp has been used as poultry deep litter which has subsequently been used with good results as livestock feed (Harms *et al.*, 1968).

TABLE 2. Digestibility of citrus feeds in trials with sheep

	Digestibility					Number of animals
	Organic matter	Crude protein	Crude fibre	Ether extract	Nitrogen-free extract	
	Percent					
Whole fresh orange		64.4	82.3	44.1	99.2	3
Silage of orange pulp		53.1	76.4	65.2	93.5	6
Dried citrus pulp	83.0	41.1	79.7	100.0	87.7	3

Citrus molasses

The liquid obtained from pressing citrus waste with 9 to 15 percent soluble solids, of which 60 to 75 percent are sugars (Hendrickson and Kesterton, 1964), can be concentrated to become citrus molasses. Without this further processing the liquor has a high biological oxygen demand and can create a waste problem if dumped into lakes or streams. It may indeed amount to more than half of the total weight of the waste.

Citrus molasses is normally a thick viscous liquid which is dark brown to almost black in colour and has a very bitter taste. This taste does not affect its usefulness in cattle feeding, however, and in fact it can be used in the same way as sugarcane molasses. It may be mixed with pressed pulp prior to drying and thus the energy content is increased in the dried product without destroying the keeping quality of the pulp. When fed free choice to cattle up to 3 kg per day are consumed. It is not so readily accepted by pigs.

Citrus seed meal

Citrus seeds are sometimes collected separately at the canning plants and subjected to an oil extraction process. The resulting oil cake is usually called citrus seed meal and compares favourably with many sources of vegetable protein. However, it contains limonin, a factor toxic to pigs and especially to poultry. Citrus seed meal is therefore unsuitable for these animals because at 5 percent inclusion it will reduce growth

and at 20 percent it will cause mortality in growing chickens (Driggers *et al.*, 1951). It is acceptable to ruminants and comparable to cottonseed oil cake with the same percentage of crude protein. There is thus no restriction on its inclusion in diets for ruminants.

Lime fruit waste

The lime fruit resembles a small orange with a thin skin, either green or yellow in colour. It is cultivated because of its aromatic taste and is processed into lime oil and lime juice. After the lime fruits have been crushed and the juice and the oil have been squeezed out, the skins are discarded. Lime processing plants are usually too small to justify a drying plant. The skins are a good feed either fresh, sun-dried or ensiled. The seeds are usually collected separately in the plant. They are rich in fat and protein and should be mixed with the skins and given only to cattle. Due to the presence of toxic factors in the seeds, they should not be fed to poultry and only with care to pigs. Such feeds tend to produce soft fat in pigs. Ruminants can, however, tolerate them.

If lime skins are fed in large quantities to dairy cows the morning milk may have a weak off-flavour and be opalescent. Farmers using the feed claim that lime skins rid cattle of ticks and give their coats a glossy sheen.

Conclusions

By-products from the citrus industry can make an important addition to the amount of locally produced feed for animals. In countries where the quantity of peel and rag from canning industries is large, drying is in most cases the preferred way of conservation because dried citrus pulp is easy to handle, to transport and to mix into compound feeds. Close to 700 000 tons of such dried citrus pulp are produced yearly in the United States. The cost of drying can be estimated at about US$40 per ton of the dry meal (10 percent moisture). Other countries producing dried citrus pulp for local use as feed include Trinidad with a yearly production of 4 000 tons and Jamaica where two plants produce a total of 4 500 tons per year.

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FUTURE ISSUES OF WORLD ANIMAL REVIEW

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Dairy courses and syllabuses

A.W. MARSDEN*

The FAO Animal Production and Health Division has always been particularly interested in developing and improving milk production and the dairy industry in developing countries and, in conjunction with the Danish Government and others, in providing dairy training facilities and courses in these countries. In 1964 the First FAO International Meeting on Dairy Education (FAO, 1964) was held in Paris, as a result of which an Expert Panel was set up consisting of ten distinguished professors and teachers from different countries. A principal duty of the Panel was to advise on improving and coordinating training and education in dairy science and technology throughout the world. It has issued three reports (FAO, 1967, 1968, 1970).

After the first meeting of the Panel in 1965, a small group of members was requested to prepare documentary material giving the relative importance of dairy science and technology subjects, so as to show a desirable pattern of dairy education and training at different levels in countries at different stages of development. Detailed working papers were prepared on the subjects to be included in dairy science and technology syllabuses at colleges and universities and the rating to be ascribed to each subject according to whether a country's dairy industry was advanced, partly developed or emerging.

It became clear that the emphasis to be given to each subject differed considerably according to the level of the course and to the stage of dairy development in the country. In a developing country more importance was attached to animal husbandry and clean milk production; in a country with a developed industry dairy science and technology were more important.

It was agreed that the main areas of study should be divided as follows:

A. Basic studies
B. Agricultural science, animal husbandry and milk production
C. Milk collection and handling
D. Milk processing and products manufacture
E. Product development and distribution

Areas of study

A. *Basic studies*

University level. It was general practice to require university students to study a number of basic courses, which varied considerably from one country to another and even from one institution to another within a country. Subjects commonly included in courses for dairy scientists and technologists were:

Physical sciences (chemistry, physics, mathematics)
Biological sciences (biology, microbiology)
Economics, social sciences and extension methods

FIGURE 1. Courses in agricultural subjects are important for dairy students in developing countries.

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Liberal arts (history, literature, philosophy).

Engineering science (fluid mechanics, heat transfer)

These basic studies often covered one to two years and were taken either before commencing the actual dairy course, or at the beginning, or distributed throughout the three to four years of the course. Some institutions limited basic studies to those essential for the development of the applied sciences (for example, studies in physical and biological sciences) but others included engineering science in addition.

In order to prepare the students for further studies or for participation in community activities, increasing attention was being paid in university and college curricula to economics, social studies and extension methods, and the inclusion of liberal arts subjects — to improve the cultural basis of technological studies — was a requirement of some institutions.

The relative weighting of these various subjects in courses for dairy scientists and technologists would depend on the state of a country's dairy industry: developed, partly developed, or emerging. The greatest divergence in weighting was likely to occur in countries where the dairy industry was well developed, and educational institutions had formed specialized groups. Strong weighting was normally given to the physical and biological sciences, and increasingly to engineering science.

It was suggested that the general weighting in the field of basic studies for institutions associated with partly developed and emerging dairy industries should follow the general pattern of the educational centres in countries with an advanced dairy industry, so that academic status for degrees could be accorded, and transfer to other university centres for higher studies could be facilitated. However, the educational requirements for scientists and technologists for partly developed or emerging dairy industries should give more emphasis to social studies.

Intermediate level. The same trends applied in general to basic science studies in subdegree or diploma courses as those recommended for degree courses, but the amount of teaching time would be considerably less because the content of the courses and the method of presentation would be different. Normally, liberal arts studies were not included in intermediate level courses.

PHOTO: KENYA MINISTRY OF INFORMATION

FIGURE 2. More time should be given to animal science subjects in dairy courses in developing countries than is usual in developed countries.

B. *Agricultural and dairy science studies*

Subjects in this group would include soils and fertilizers; pastures; crops and crop preservation; animal husbandry; animal health; dairy farm engineering; milking techniques and hygiene; and dairy farm management.

C. *Milk collection and handling*

Subjects would be cooling and refrigeration; milk collection; transport; reception and control; and dairy organization.

D. *Milk processing and products manufacture*

Subjects would include dairy and food chemistry and microbiology; human nutrition; milk plant laboratory techniques and quality control; judging and control; unit operations; milk processing and manufacture techniques; dairy engineering; maintenance and repairs; design, organization and management of milk plants.

E. *Product development and distribution*

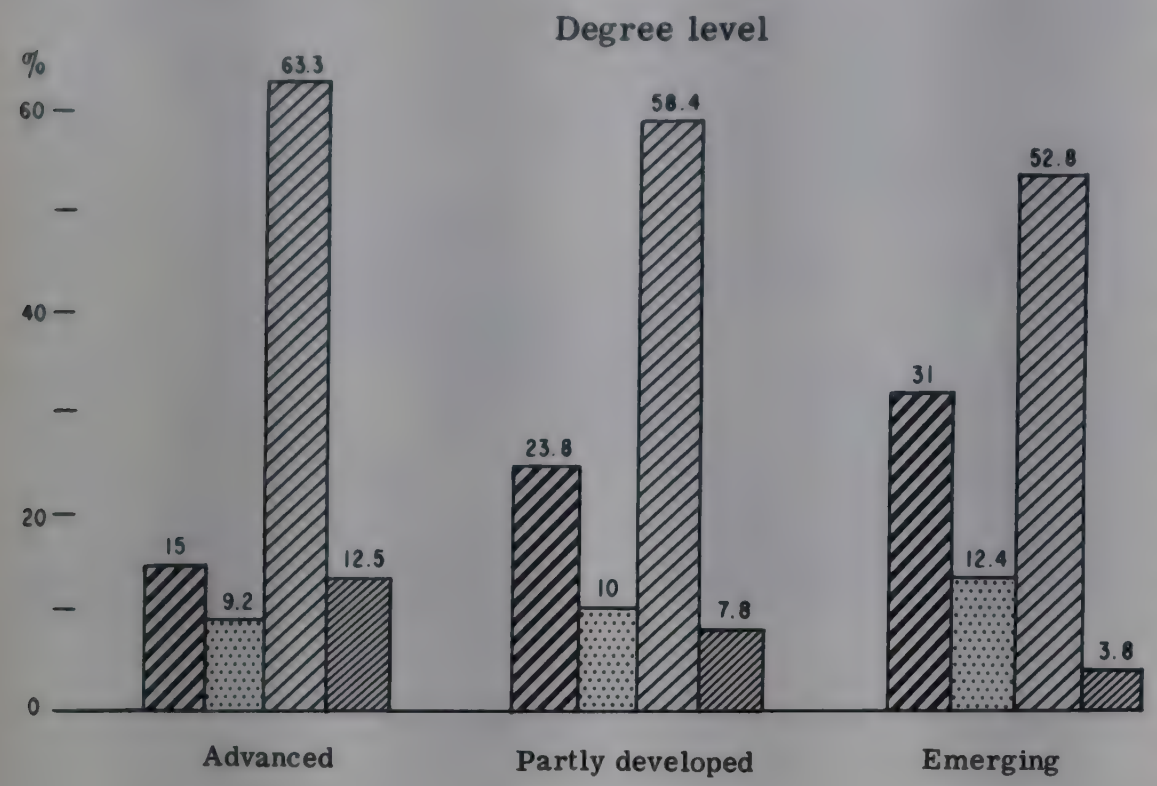
Studies would cover distribution; product development; marketing and consumer surveys.

Weighting of studies

In order to assist those responsible for planning and running dairy science and technology courses it was agreed that numerical values should be attached to each field of study but that such numbers were to be used merely for weighting the relative importance of the subjects. This work was done by the small group of Panel members between the second and third meetings of the Panel and was presented in tabular form in the report of the third meeting (FAO, 1970).

These guidelines emphasized the importance of agricultural subjects (such as animal husbandry, milk production, and farm management) for countries with emerging dairy industries, and of processing and product development for those with developed industries. These extremes were rated differently for degree

FIGURE 3. Percentage of the dairy student's time to be devoted to the main groups of subjects studied at degree and diploma levels in countries with advanced, partly developed and emerging dairy industries.



courses and intermediate level courses; for instance, agricultural science took up a smaller proportion of the curriculum in degree courses than in intermediate level courses.

The Panel recommended that the numbers given under each subject for the three main categories of dairying (advanced, partly developed and emerging) should be expressed in the form of suitable diagrams. These have now been prepared as histograms (Figure 3).

It will be seen that the need for agricultural and animal science subjects (group B) in the curriculum for both degree and intermediate (diploma) level courses is highest where the degree of development of the dairy industry is lowest. Conversely, in countries with an advanced dairy industry more time needs to be spent on the subjects in group D (technology, processing). Similar trends can be seen in the time to be devoted to subjects in groups C and E.

Conclusions

The Panel's findings on dairy training courses and syllabuses indicate that requirements differ from country to country according to (*a*) the level of training to be undertaken and (*b*) the stage of development of the dairy industry in a particular country. Both factors should be considered when courses and syllabuses are prepared.

The work done by the FAO Expert Panel on Dairy Education for dairy science and technology courses could well be repeated in other spheres of study in the animal world.

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FAO. 1970. *Report of the third Meeting of the FAO Expert Panel on Dairy Education, 1969.* Rome.

International symposium on dermatophilus infection

This symposium, which will be held at the University of Ibadan from 25 to 30 June 1973, under the auspices of the Agricultural Research Council of Nigeria, will cover all aspects of disease caused by *Dermatophilus congolensis*, but with an emphasis on epidemiology and methods of treatment and control. Those interested should write (airmail) to:

Joint Secretary,
International Symposium on Dermatophilus Infection,
Department of Veterinary Pathology,
University of Ibadan, Nigeria

FAO/OIE Ad Hoc Consultation on the control of protozoal tick-borne diseases of cattle

This meeting of experts, organized under the aegis of FAO's Animal Health Service and of the International Office of Epizootics (OIE), under the chairmanship of Professor Rafyi (Iran) who represented OIE, brought together eight specialists on the control of protozoal tick-borne cattle diseases from all over the world. They were Dr. S.F. Barnett (United Kingdom), Dr. H.K. Dennig (Federal Republic of Germany), Dr. R.C. Drummond (United States), Dr. D.F. Mahoney (Australia), Dr. P. Morel (France), Dr. T.R. Odhiambo (Kenya), Dr. E. Pipano (Israel) and Dr. R.H. Wharton (Australia). Also present at the meeting were observers from WHO (Dr. R.C. Fontaine), from the Inter-African Bureau of Animal Resources (Dr. P.G. Atang and P. Ndertito), from the Kenya Veterinary Service, and from FAO projects working on the control of tick-borne diseases in east Africa.

Fourteen working papers relating to subjects on the agenda introduced the discussions and provided details of the control of ticks (use of acaricides, the resistance of ticks to acaricides, the possibilities for biological control of ticks), the control of cattle protozoal diseases transmitted by ticks (babesioses and theilerioses) by means of chemical therapy as well as by vaccination, the economic aspects of the control of these diseases and the necessity for further research.

The experts formulated recommendations for a better dissemination of information, the development of research into biological control, the use of acaricides and the problems of the resistance of ticks to acaricides, and the necessity for research on ticks and the diseases they transmit.

The report of this meeting and the working papers will be published by FAO, in French and in English, early in 1973.

P.F.

International Dairy Federation meeting

The fifty-sixth annual meeting of the International Dairy Federation will be held this year in Brussels from 17 to 22 September 1973. Details can be obtained from:

Mr. P. Staal,
General Secretary,
International Dairy Federation,
Square Vergote 41,
1040 Brussels, Belgium

FAO/WHO rodent bibliography

To facilitate access to the voluminous literature on rodents, their distribution, ecology and control, the preparation of a bibliography has been undertaken jointly by FAO and the World Health Organization (WHO). It covers the period 1960-69 and includes some 7 000 references taken from many periodicals, journals, reports and abstracting journals. In selecting these periodicals, efforts were made to include literature from as many countries as possible in order to provide information on the scope and magnitude of rodent problems. Many references include a short annotation indicating the main points covered by the article concerned. Although some articles may have been missed, it is nevertheless hoped that this document will facilitate the work of research scientists and rodent control specialists in literature searches in connexion with their work.

The subjects covered include the identification, distribution, biology, ecology and behaviour of rodents; the economic importance of rodents in relation to stored food products, agriculture and forestry; rodents as vectors of animal disease; the public health importance of rodents and their ectoparasites; methods, measures and materials for rodent control, including chemical, biological, mechanical and environmental control.

The bibliography has been prepared in English only, although the references come from literature from all over the world. As distribution is limited, those interested in having a copy should describe their need for it and send their request to:

Dr. H.R. Shuyler,
Plant Production and Protection Division, FAO, 00100 Rome, Italy

or Dr. N.G. Gratz, Vector Biology and Control, WHO, 1211 Geneva 27, Switzerland

Letter to the editor

DANIDA and ISCDD

Sir,

I should like to correct an error in my article on the International Scheme for the Coordination of Dairy Development which appeared in the *World Animal Review*, No. 4, 1972. On page 36, column 3, paragraph 3, the sentence "The Danish aid organization, DANIDA, has agreed to finance a dairy training centre and demonstration farm which will also have a herd of good quality stock," should read instead " The Danish aid organization, DANIDA, has stated interest in assisting with a project for dairy training and extension."

Yours, etc.

Jan Rendel
Chief, Animal Production Service
Animal Production and Health Division
FAO, Rome, Italy

Pig production: husbandry, economics and products

Porcinocultura: explotación del cerdo y sus productos. ANTONIO CONCELLÓN MARTÍNEZ. Biblioteca Agrícola Aedos, Barcelona, 1972. 546 pages, 105 figures, 42 photographs, numerous tables. Price: 500 pesetas. (In Spanish)

This is one of the few books in Spanish dealing exclusively with pig production. Previous editions were published in 1960 and 1965 and the current one has been considerably revised.

There is very little Spanish literature concerned with this subject, especially when compared with that in English and German. This is unfortunate because in Latin America pig production is playing an increasingly important role in the national economy of the countries. This book therefore fills an important need, not only for Spain but also for Latin America.

The book contains 13 chapters and is well illustrated with figures, photographs and tables. It starts with a general review of the economic aspects of pig production and explains the origins, anatomical and physiological aspects, genetics, selection and utilization of the different breeds. It describes various housing systems, and the nutrition of piglets, growers, fatteners and breeding stock. There are other sections on pig diseases and their control, as well as on management and marketing.

This book is a source of useful information and can be recommended to teachers, students, extension officers and farmers.

D.K.

Animal waste management

Proceedings of National Symposium on Animal Waste Management, 1971, Warrenton, Virginia. Council of State Governments, 1735 DeSales Street, N.W., Washington, D.C. 20036, United States, 1972. 205 pages, 20 figures and 22 tables. Unpriced. (In English)

The proceedings include the papers and discussions at the symposium, which was held with the aim of finding solutions to the problems of improving the management, disposal and recycling of agricultural waste in the United States, and starting action programmes.

Among the 20 chapters, one on state activities in animal waste management gives information on regulations pertaining to livestock feedlots in a number of states and includes a model state statute for animal waste control.

A chapter on research and technology has an informative section about effluent discharge guidelines and animal waste management technology, and separate sections on waste from dairy cattle, poultry and pigs, and cattle feedlot pollution.

The authors of the section on the recycling of animal wastes indicate that many people visualize production as a simple system: feed and water are the inputs and animal products and waste are the outputs. Such a system is inefficient as it fails to take advantage of the feed value left in wastes and these are considered environmental contaminants. Although 100 percent recycling is seldom attained, it could be the ideal by which success is measured.

A paper on government technical and financial assistance describes research activities, extension service, training activities, credits and grants.

The recommendations adopted at the symposium are classified under six different headings: information programmes, education and training programmes, technical assistance, financial assistance, research and development, and legislation and regulation.

Although the contents refer to conditions in the United States, the publication is of great interest to other people dealing with industrial livestock production as it gives the views of people who may be engaged primarily in legislation, engineering, animal nutrition, pollution, education, extension, credit administration and so on, but who are all faced with aspects of the same problem — animal waste management.

J.M.W.

The employment of draught animals in agriculture

Prepared by the Research and Experimental Centre for Tropical Mechanical Agricultural Equipment (CEEMAT) and the Institute for Animal Production and Veterinary Medicine in Tropical Countries (IEMVT), and translated by FAO. FAO, Rome, 1972. 249 pages, 182 figures, numerous tables, 55 references. Unpriced. (In English)

This manual was originally published in 1968 in French for the officers and technicians of the agricultural services in the French-speaking countries of Africa. FAO has prepared this English edition to enable English-speaking people, not only in Africa but also in other developing countries, to utilize the information it contains.

There are four main parts. The first deals briefly with the principal draught animals (cattle, horses, donkeys, mules and camels) found in west Africa and gives some details of the breeds, health, care, training, housing and feeding as well as types of harnesses in use.

The second part is the largest and includes many figures and much information on animal-drawn implements for cultivation, sowing, harvesting and so on, on small farms.

The section on rural handicrafts gives some guidance on making and repairing farm implements. Another part deals with the economic aspects of animal-drawn implements and, in an annex, gives a simple method of calculating the cost of using draught animals in the tropics.

Although this manual may have some limitations (for example, no reference to buffaloes) it nevertheless contains much valuable technical information on field operations in tropical countries which utilize draught animals.

A.W.M.

Beef cattle

Il bovino da carne (Beef cattle. Criteria and modern techniques in beef production. Biological and economic aspects of meat). T. BONADONNA. Edagricole, Bologna, 1972. Second edition. 443 pages, 98 tables, 97 figures. Price: 5 000 lire. (In Italian)

Payment for milk on quality
1973, 82 p.

Food value of milk, diseases of dairy cows, production methods and handling of milk before it reaches the plant, tests for hygiene and composition, quality control and payment schemes in advanced dairy industries, as well as implementation of such schemes in developing countries, are featured in this FAO agricultural study. A helpful guide for administrative officials, advisory workers, plant managers and other interested personnel in countries with a developing industry. $2.00 or £0.80

Amino-acid content of foods and biological data on proteins
1970, 285 p. 1972, 2nd printing

Tables which show the level of amino acids in foods and the scores; the data relating to biological value, digestibility, net protein utilization, and protein efficiency rate. $12.00 or £4.80

Encouraging the use of protein-rich foods
by J. Fridthjof. 1962, 103 p. 1971, 4th printing

A guide to planning and conducting campaigns to introduce protein-rich foodstuffs as a valuable means of fighting malnutrition and improving nutritional standards. $1.00 or £0.40

Emerging diseases of animals
1963, 241 p. 1968, 2nd printing

Six important diseases are dealt with — African swine fever, African horsesickness, Bluetongue, Johne's disease, Lumpy skin disease and Enterotoxemia of sheep. $4.00 or £1.60

Animal husbandry - introduction (28 p.)

Animal husbandry - feeding animals (32 p.)

Animal husbandry - looking after animals - how cattle reproduce (31 p.)

Animal husbandry - what cattle produce (24 p.)

1970. 1972, 2nd printing

From the Better Farming Series published by arrangement with the Institut africain pour le développement économique et social. This series covers in a very simple form all practical aspects of agriculture, for use by village-level extension instructors, farmers' groups and schools, especially in developing countries. each $0.25 or £0.10

Processing and utilization of animal by-products
by I. Mann. 1962, 246 p. 1967, 2nd printing

Describes selected processes as well as inexpensive equipment for the rural industrial use of such animal by-products as blood, bones, hooves, horns, inedible meat, which are often wasted. $3.00 or £0.75

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Information Canada, Ottawa.

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